

# A search for pulsed radio emission from anomalous X-ray pulsar 4U 0142+61 at the frequency of 111 MHz

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## ABSTRACT

We have searched for pulsed radio emission from magnetar 4U 0142+61 at the frequency of 111 MHz. No pulsed signal was detected from this source. Upper limits for mean flux density are 0.9 - 9 mJy depending on assumed duty cycle (.05 - .5) of the pulsar.

## 1. Introduction

4U 0142+61 is an anomalous X-ray pulsar (AXP) with 8.7 seconds period. At period derivative  $\dot{P} = 2 \times 10^{-12}$  magnetic field on a surface of a neutron star equals to  $1.3 \times 10^{14}$  G - typical value for magnetars. The pulsar can be seen in hard X-ray (Den Hartog et al. (2006), Kuiper et al. (2006)), optical (Kern & Martin (2002)), and infrared (Hulleman et al. (2004), Wang et al. (2006)) bands. We searched for pulsed radio emission of this AXP at the frequency of 111 MHz.

## 2. Observations and Data Reduction

The observations were performed from December 2000 through March 2007 with the Large Phase Array (BSA) radio telescope at Pushchino Radio Astronomy Observatory with an effective area at zenith of about 15,000 square meters. One linear polarization was received. We used 128-channel receiver with a channel bandwidth of 20 kHz and a center frequency of 110.59 MHz. The observations were carried out in the mode of recording individual pulses. The sampling interval was 25.4 ms at the receiver time constant  $\tau = 30$  ms. Since BSA radio telescope is a transit one, the duration of one observing session is limited to 6.7 min. A total of 540 observational sessions containing 25,920 periods of the pulsar was carried out. Since the middle of 2004 antenna was calibrated by observations of the 3C 452 source, flux density of which at 111 MHz is considered as 91 Jy.

At primary processing of day observation session, a mean value was deduced from time-series in each frequency channel and a result was divided by mean square deviation of the channel.

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Then records were reviewed to reveal interference, namely: records of all channels were averaged without compensation for dispersion delay (as ground interferences have no dispersion delay) and if interference was revealed (with signal to noise ratio of seven or higher) then corresponding values were substituted with zero at all channels. Further: folding, that is summation of periods in record of each channel, was performed; at that, period meaning for a special day of observations was calculated on the base of recent ephemeris of Dib et al. (2006). And finally: compensation of dispersion delay was performed for each channel; at that, dispersion measure was searched in the range from 0 to 200 pc cm<sup>-3</sup> with spacing of 2 pc cm<sup>-3</sup>. The proposed distance (3.6 kpc) to 4U 0142+61 corresponds to dispersion measure  $DM = 96$  pc cm<sup>-3</sup>. No statistically meaning radio emission was found in any series of observations.

### 3. Results

To improve the sensitivity of the search, all 540 observational sessions were averaged together by time reference in accordance with ephemeris of Dib et al. (2006) and with above mentioned searches of dispersion measure. We did not reveal any significant radio emission at this processing either. Examples of resulting means (for all 540 sessions) of pulse profiles for a number of dispersion measure values are presented at the figure. Value of upper limit ( $5\sigma$ ) for a peak flux density equals to 18 mJy. A correspondent value of the mean (by period) upper limit is within 0.9 to 9 mJy range depending on a assumed (.05 to .5 of period) pulse duration.

### 4. Conclusion

The search of pulsed radio emission from anomalous X-ray pulsar (magnetar) 4U 0142+61 at the frequency of 111 MHz give no positive results. Upper limits for mean flux density are 0.9 - 9 mJy depending on assumed duty cycle (.05 - .5) of the pulsar.

### 5. Acknowledgements

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### REFERENCES

Den Hartog, P. R., et al. 2006, A&A, 451, 587

- Dib, R., Kaspi, V. M. & Gavriil, F. P. 2006, astro-ph/0610932
- Hulleman, F., van Kerkwijk, M. H., & Kulkarni, S. R. 2004, A&A, 416, 1037
- Kern, B. & Martin, M. 2002, Nature, 417, 527
- Kuiper, L., et al. 2006, ApJ, 645, 556
- Wang, Z., Chakrabarty, D., & Kaplan, D. L. 2006, Nature, 440, 722

4U 0142+61, 111 MHz

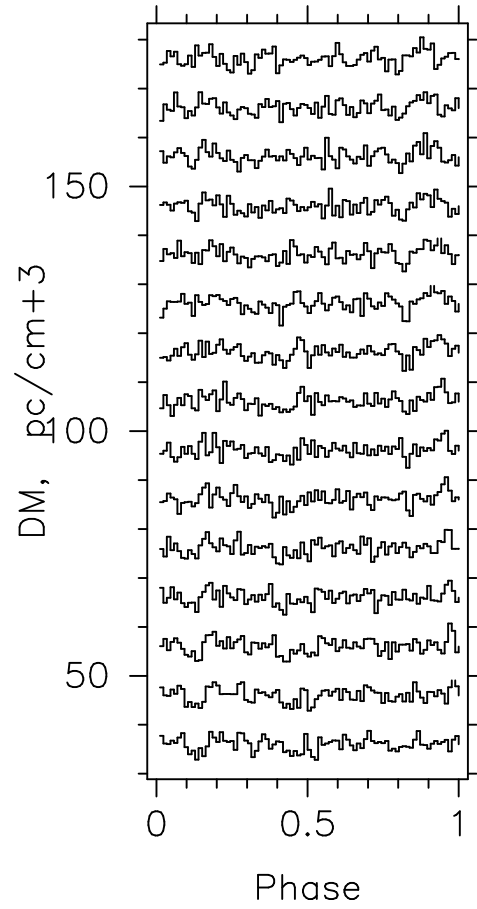


Fig. 1.— The average profiles of 4U 0142+61 at the frequency of 111 MHz for a number of dispersion measure values.